APPENDIX 3

TEMPORAL VARIATIONS IN METAL CONTENTS IN SELECTED WATERS AT THE SOUTH BAY MINE SITE

FINAL REPORT 1995

NOVEMBER, 1995

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TEMPORAL VARIATIONS IN METAL CONTENTS IN SELECTED WATERS AT THE SOUTH BAY SITE

I. INTRODUCTION

Boojum Research initially requested that simulations (using WATEQ and NETPATH) be applied to the analyses of July and August 1994 samples from various sources around the Mill site (WHS, BRC, PRC, PRS, MPO, BR13, C13), for comparison with the results of similar simulations applied to the analyses of July and August 1992 samples from the same sources. The prime objective of this exercise would have been to elucidate the effects of the various ditches constructed at the site. No simulations have been performed, however, because the analyses representing the July and August 1994 samples from these sources are incomplete, missing all major ions.

Available analyses for samples collected from a number of selected points at the South Bay site, between October 1986 and September 1994, have been plotted to determine where heavy-metal concentrations are increasing or decreasing with time. In the graphs, the lines representing [Cu] and [Zn] are drawn heavy to make recognition easier.

It has been assumed that the analyses are representative for the chemical composition of the various sources at the time of sample collection. If additional analyses exist for the locations represented by these graphs, incorporation of such analyses should probably be considered.

It should be kept in mind that the detection limits for the heavy metals were apparently set at 1.0 or 0.1 mg/L, rather than 0.01 mg/L or lower, for some of the pre-1994 analyses. Thus some of the graphs may give the erroneous impression of very low metal concentrations during the early 1990's.

II. RESULTS

A. Mill Site to Boomerang Lake

1. Piezometer M38

Shows decreases in the values for [Al], [Cu], and [Zn], and a possible increasing trend for [Mn]. This may reflect depletion of the metals available from the former storage location, or the effect of the NN ditch. High detection limits for metals in samples collected in March and July 1992 leave some uncertainty.

2. Warehouse Seep (WHS)

Shows increases in the values for [Al], [Cu], and [Fe], but no clear trend for [Mn] and [Zn]. Some seasonal variations.

3. Backfill Raise Cap (BRC)

Shows increases in the values for [Al] and [Fe], and decreases in the values for [Cu], [Mn], and [Zn]. Seasonal variations are stronger than in WHS.

4. Drainage Ditch (BR4 and BR2.5)

The 1994 analyses for location BR2.5 show increases in the values for all metals compared to samples collected from location BR4 in 1992. Apparent seasonal variation is strongest in [Fe].

5. Mill Pond Outlfow (MPO)

Metal concentrations show seasonal variations in both 1992 and 1994, but they were overall lower in 1994.

6. Boomerang Lake Oufflow (B1)

Shows increases in the concentrations of all five metals, more than an order of magnitude from 1990 to 1992, somewhat smaller increases from 1992 to 1994. All metal concentrations, with the exception of Cu, were well above 1 mg/L in 1994. Small seasonal variations.

7. Confederation Lake Inflow (C1)

Seasonal variations are stronger than in at site B1. The 1994 values (above 1 mg/L for Zn and Mn) are somewhat lower than those for the same months in 1992. There is some uncertainty regarding [Al] and [Cu], due to the higher detection limits used for the 1992 samples.

B. Mill Site to Confederation Lake

1. Piezometer M18

The 1994 values for all five metals appear to be lower than those for pre-1992 samples; 1994 values for [Mn] and [Zn] are lower than the August 1992 values; some uncertainty regarding [Al], [Cu], and [Fe] is due to higher detection limits for earlier 1992 samples.

2. Seeps (BR13, 13B and 13C)

Strong seasonal variations occurred in all five metal concentrations, primarily due to varying degrees of dilution with time. Overall the 1994 values for all metals are lower than the 1992 values. This may well reflect the effect of the drainage ditches.

3. Portal Raise Cap (PRC)

Shows some seasonal variations. Overall, the 1994 values for all metals are higher than the 1992 values.

4. Portal Raise Seep (PRS)

Strong seasonal variations occurred in 1992, smaller variations in 1994. The 1994 values for [Fe], [Mn], and [Zn] are higher than those for 1992; the 1994 values for [Al] and [Cu] are within the ranges for these metals for 1992. In 1994 the metal concentrations were higher in the PRS samples than in the PRC samples.

5. Confederation Lake Shore (CS13)

Metal concentrations show some seasonal variation for 1994, with a possible increasing trend for Mn and Zn. The 1994 values, all below 1.0 mg/L, are apparently lower than those for 1992, but it should be established whether the samples for the two years were collected at the same site.

C. Tailings to Confederation Lake

1. Piezometer M54

Some seasonal variations. Since 1989 there have been increases in [Al], [Fe], and [Zn]; a decrease in [Cu]; and little change in [Mn].

cs54

Some seasonal variation; the available record is too short to discern any long-term trend. After initial concentrations of Fe and Mn above 4 mg/L in March 1994, all metal concentrations were lower than 0.1 mg/L in later 1994 samples.

2. Piezometer M55

Fairly strong seasonal variations. The record is too incomplete to discern any trend.

cs55

Some seasonal variation; the available record is too short to discern any long-term trend, except for [Zn] which seems to be decreasing. All metal concentrations were lower than 0.25 mg/L in 1994.

3. Piezometer M56

Fairly strong seasonal variations. **No** long-term trend discernible.

CS56

Some seasonal variation; the available record is too incomplete to discern any long-term trend. All metal concentrations were lower than 0.25 mg/L in 1994.

D. Tailings to Mud Lake and Confederation Lake

1. Decant Pond Ouflow (DPO)

Some seasonal variations. In 1994 all [Mn] and [Zn] values were lower than those in 1992. Trends for [Al], [Cu] and [Fe] are uncertain, due to strong seasonal variations; 1992 data for these may be missing due to higher detection limits (1.0 or 0.1 mg/L).

2. Mud Lake Groundwater Seepage (ML27)

The available record is too short to discern any trend. Most of the variations may be seasonal. On both sample dates, the bottom samples were considerably higher in metal content than the surface samples, reflecting discharge of metal-bearing groundwater through the bottom of Mud Lake. All Fe, Mn, and Zn concentrations were well above 5 mg/L.

3. Mud Lake Ouflow (ML18)

Some seasonal variations (higher than average concentrations in March, followed by lower than average concentrations in April) except for [Zn] and [Cu]. The data for [Zn] suggest a long-term increase. After April 1994, all Fe, Mn,and Zn concentrations exceeded 5 mg/L

4. Confederation Lake Inflow (C11)

Some seasonal variations. The available record is too incomplete to discern any longer-term trend, due to higher detection limits in 1992.

III. **CONCLUSIONS** and **RECOMMENDATIONS**

1. If chemical analyses exist for additional 1990-1994 samples from the sources reviewed in this report, those analyses should be added to the appropriate source files, and included in future review.

2. The detection limits used in the analytical procedures for future samples from the South Bay site should be the same as those used for the August/September 1994 samples.

3. If any chemical simulation exercises are intended, **major** ions should be included in the analyses, which should cover the same parameters as the analyses for the August/September 1994 samples

4. If at all feasible, the sampling frequency used in 1994 should be used for future monitoring, to make it possible to separate longer-term trends from seasonal variations.

Robert O. van Everdingen
5 April 1995

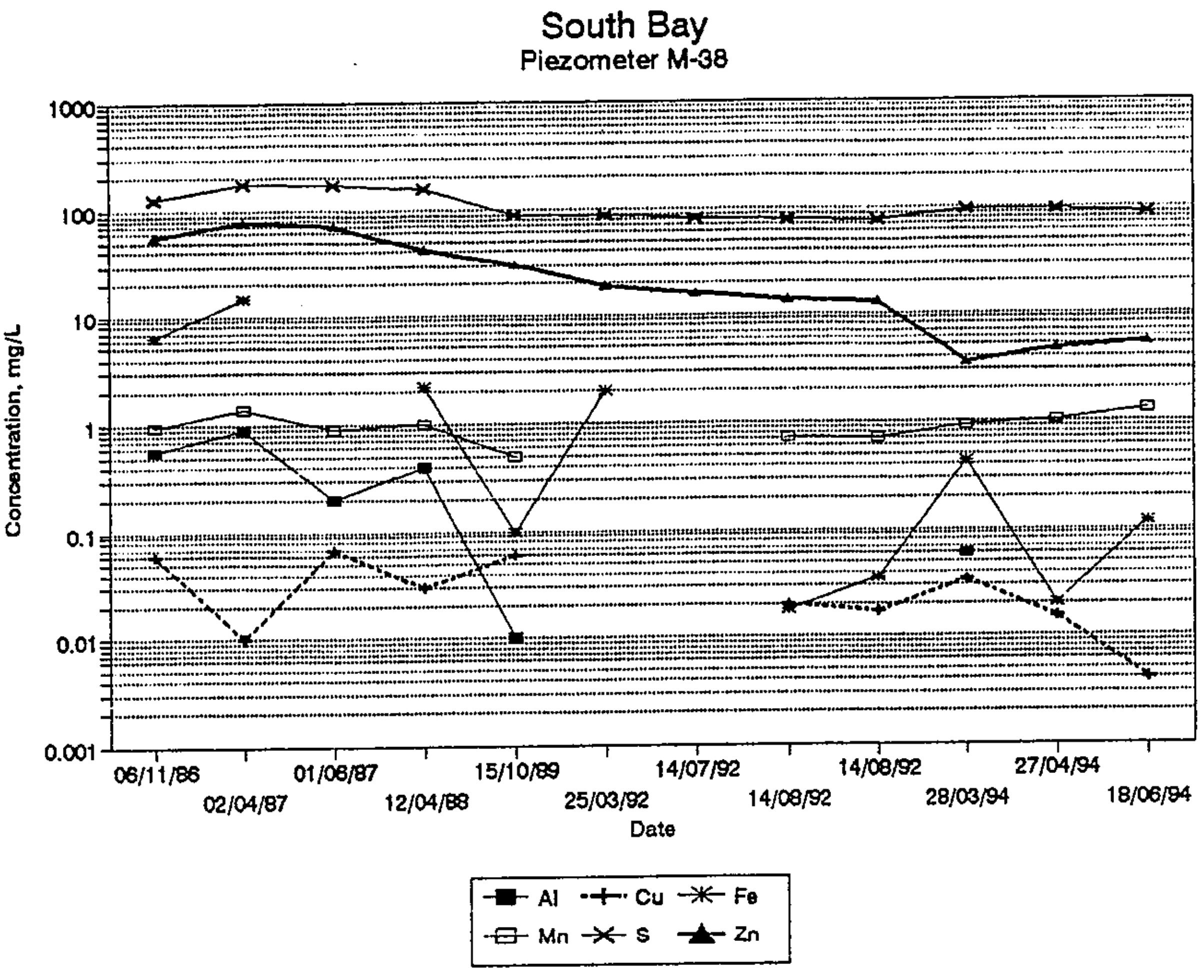

South Bay
Piezometer M-38
1000
100
10
1
0.1
0.01
0.001
Concentration, mg/L
06/11/86
02/04/87
01/08/87
12/04/88
15/10/89
25/03/92
14/07/92
14/08/92
14/08/92
28/03/94
27/04/94
18/06/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 1

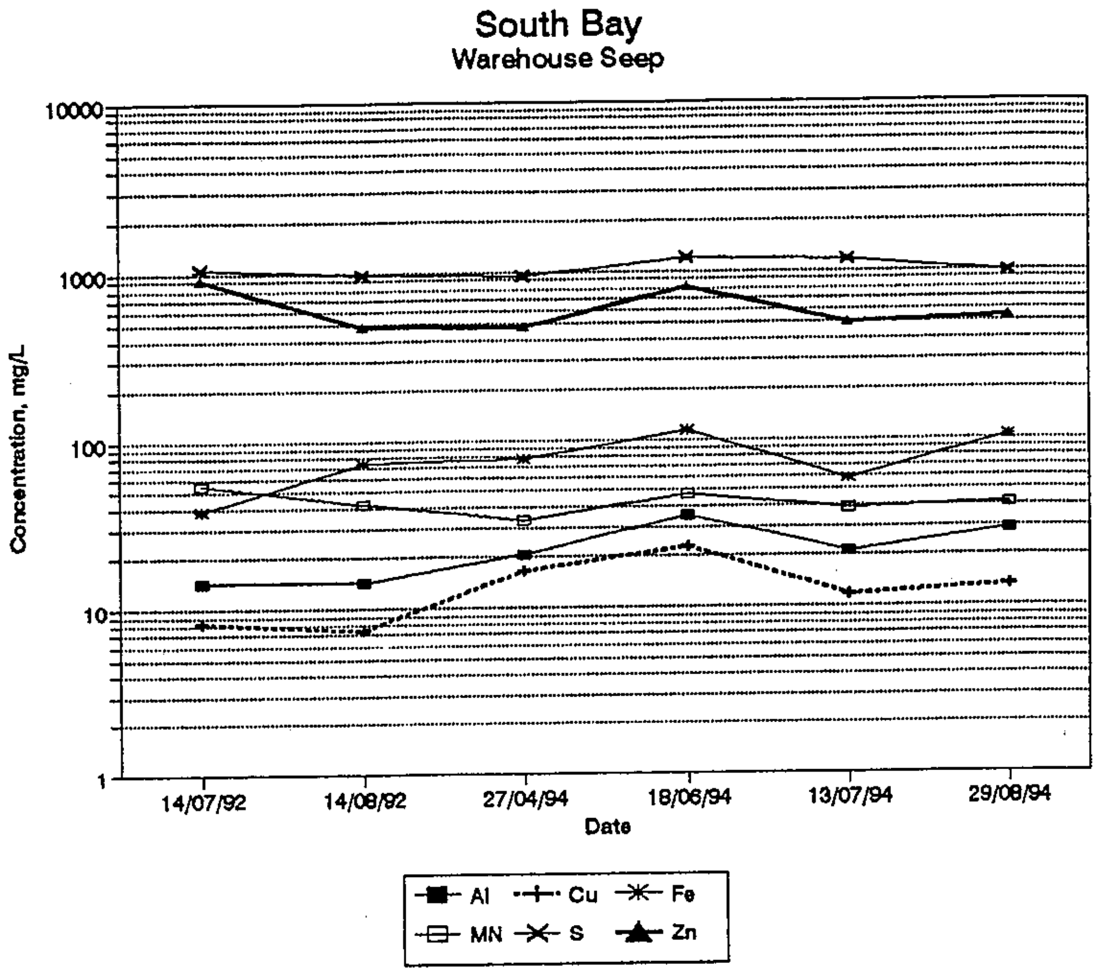
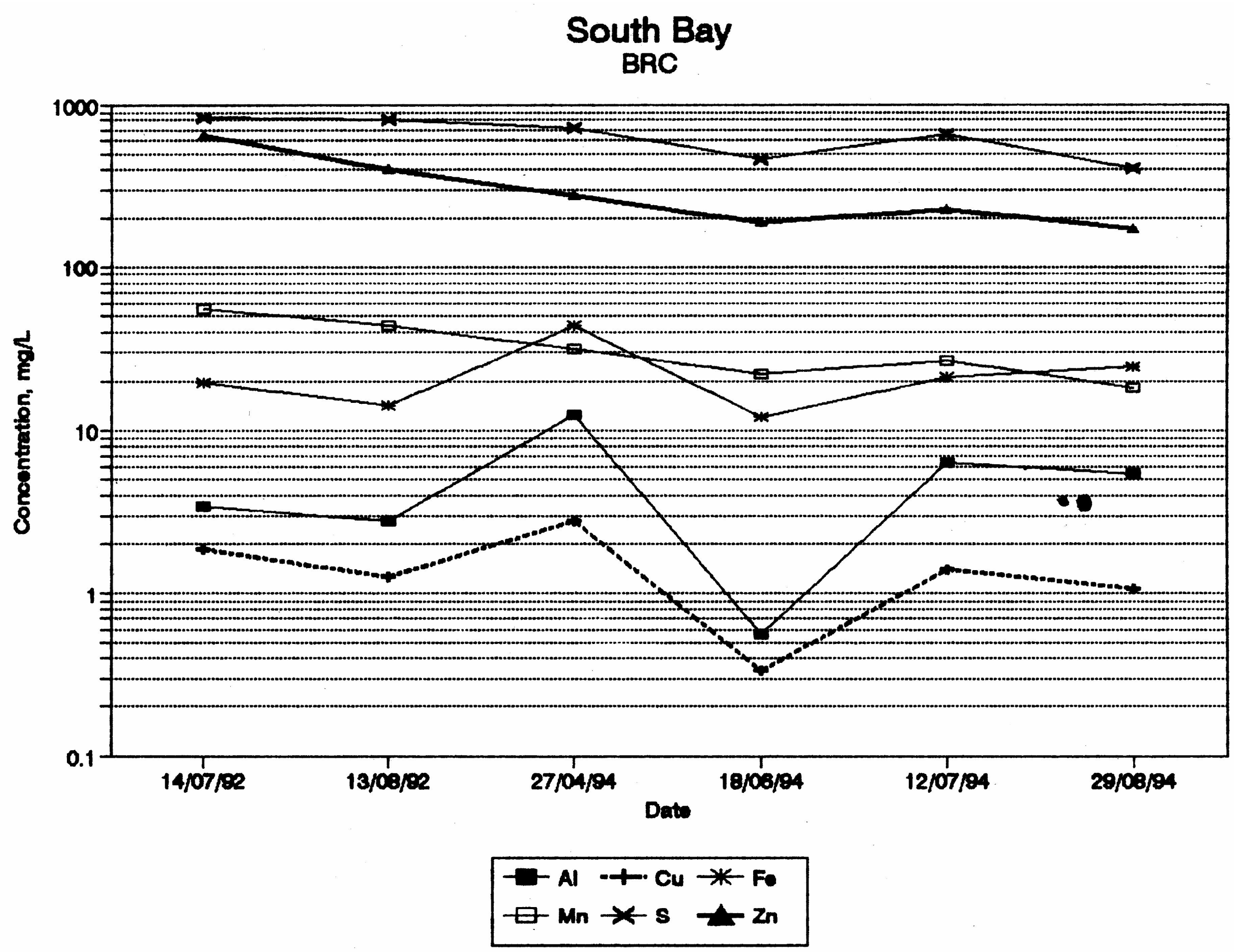

South Bay
Warehouse Seep
10000
1000
100
10
1
Concentration, mg/L
14/07/92
14/08/92
27/04/94
18/06/94
13/07/94
29/08/94
Date
Al
Cu
Fe
MN
S
Zn

FIGURE 2

Figure 3


South Bay
BRC
1000
100
10
1
0.1
Concentration, mg/L
14/07/92
13/08/92
27/04/94
18/06/94
12/07/94
29/08/94
Date
Al
Cu
Fe
Mn
S
Zn

South Bay

BR4-BR2.5-BB

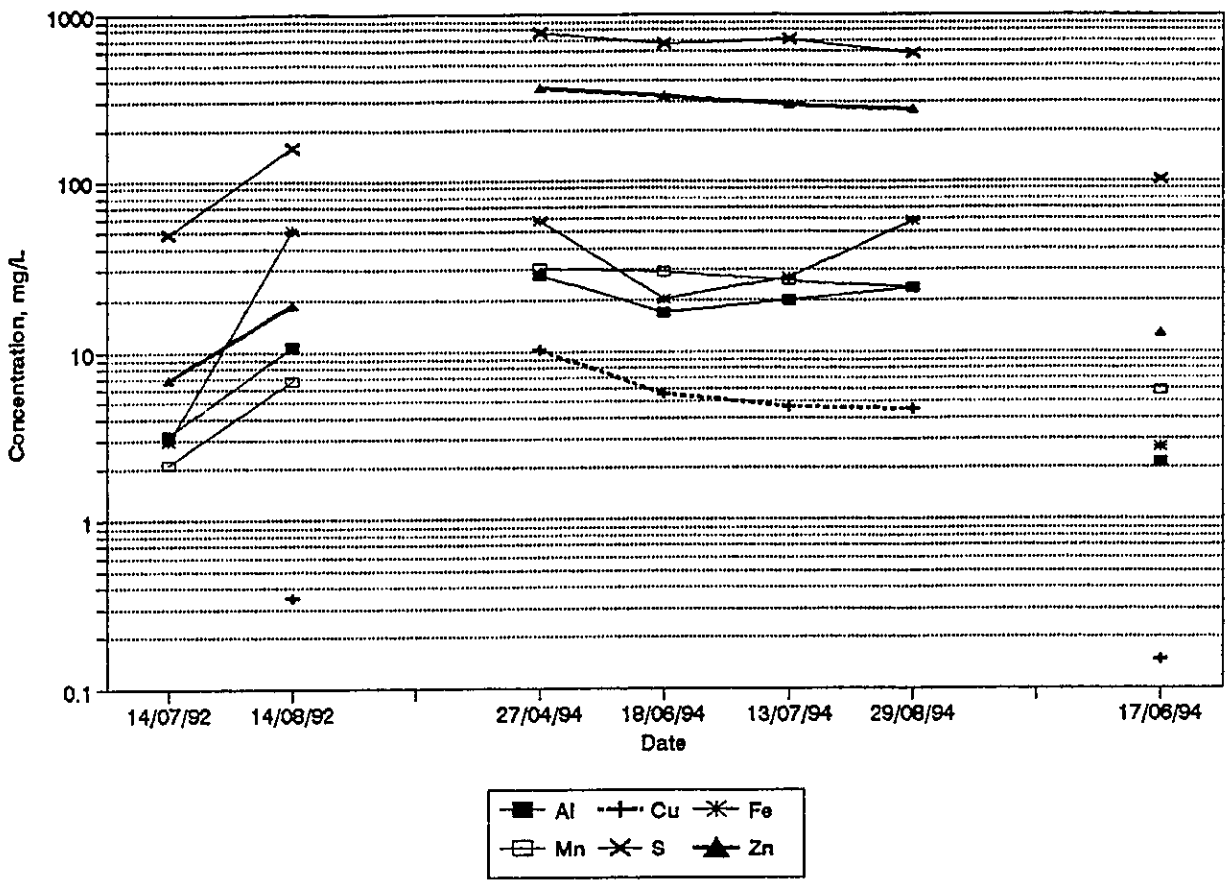


FIGURE 4

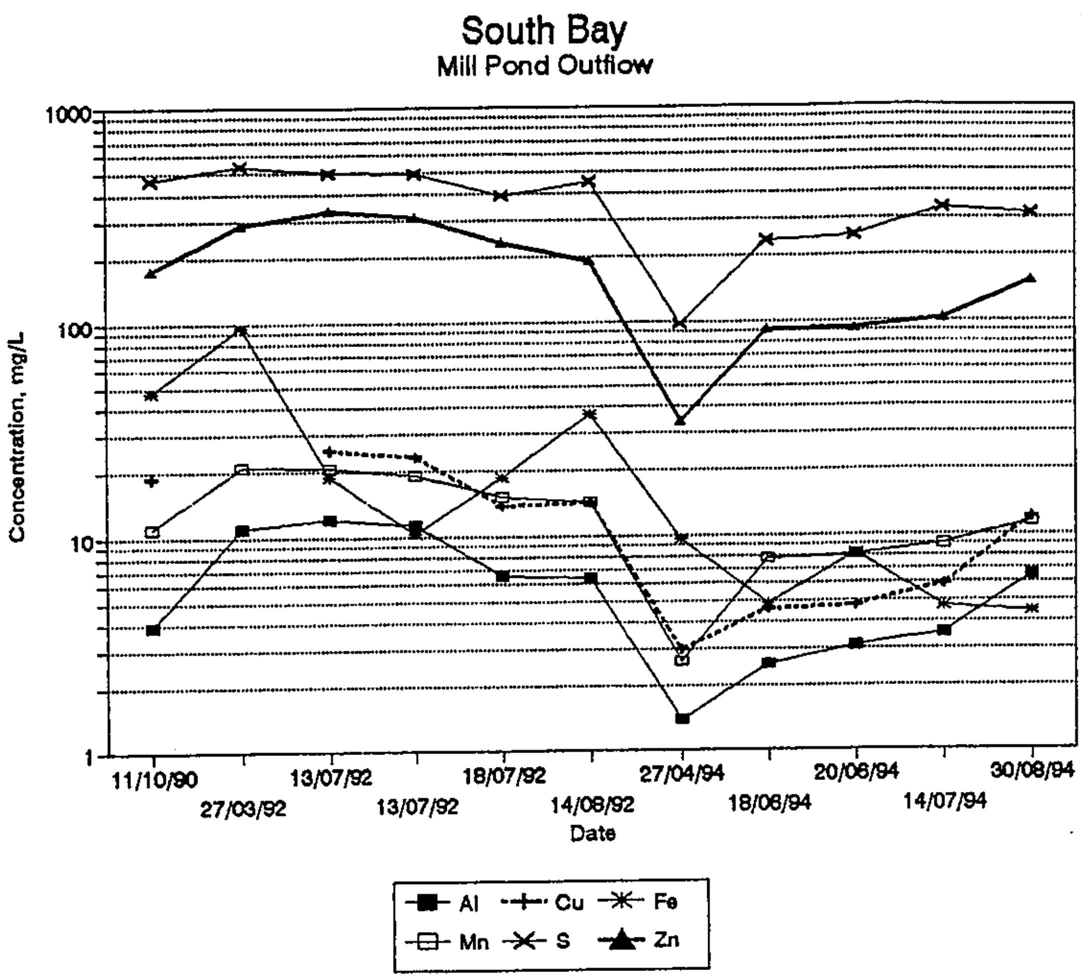

South Bay
Mill Pond Outflow
1000
100
10
1
Concentration, mg/L
11/10/90
27/03/92
13/07/92
13/07/92
18/07/92
14/08/92
27/04/94
18/06/94
20/06/94
14/07/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 5

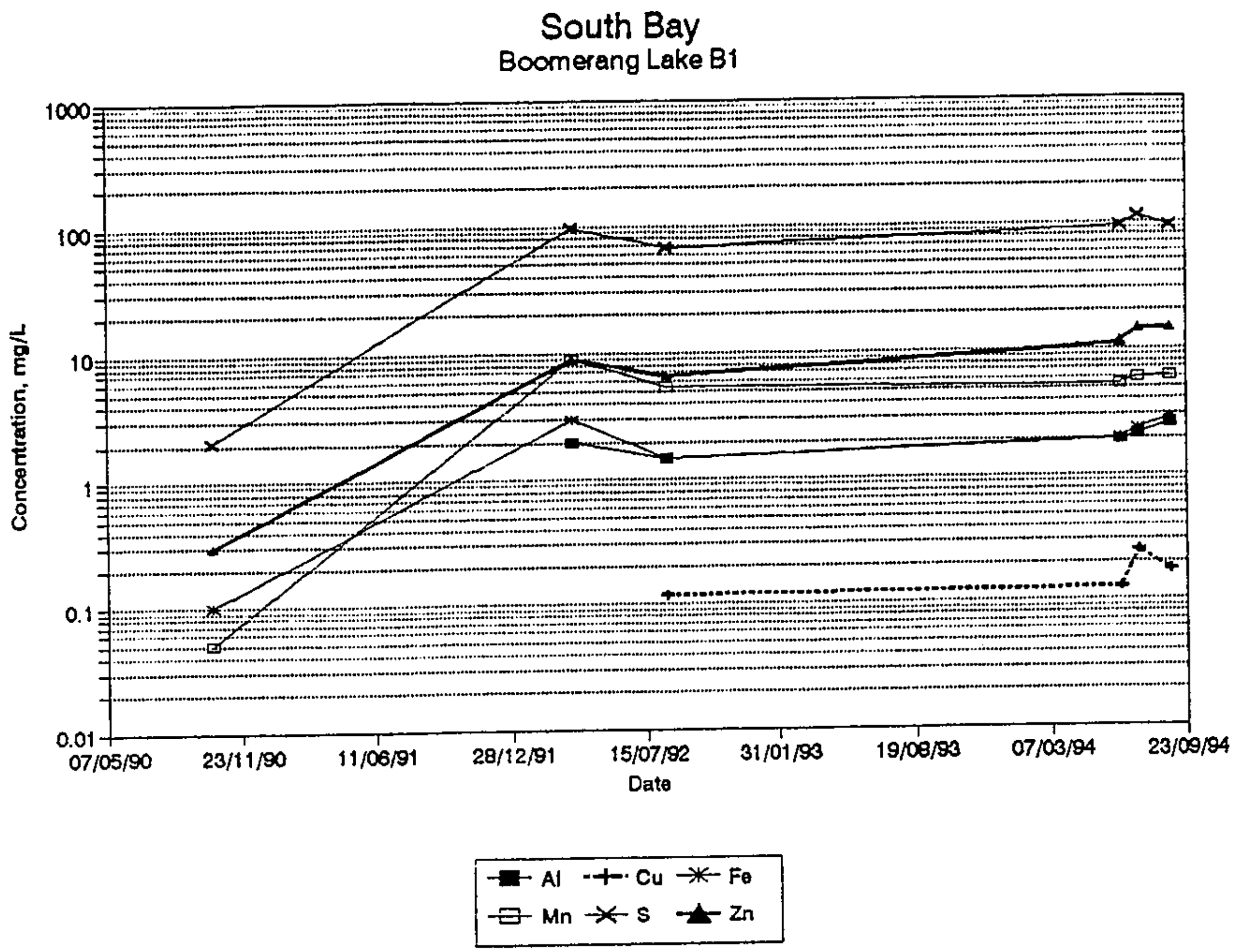

South Bay
Boomerang Lake B1
1000
100
10
1
0.1
0.01
Concentration, mg/L
07/05/90
23/11/90
11/06/91
28/12/91
15/07/92
31/01/93
19/08/93
07/03/94
23/09/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 6

South Bay
C1

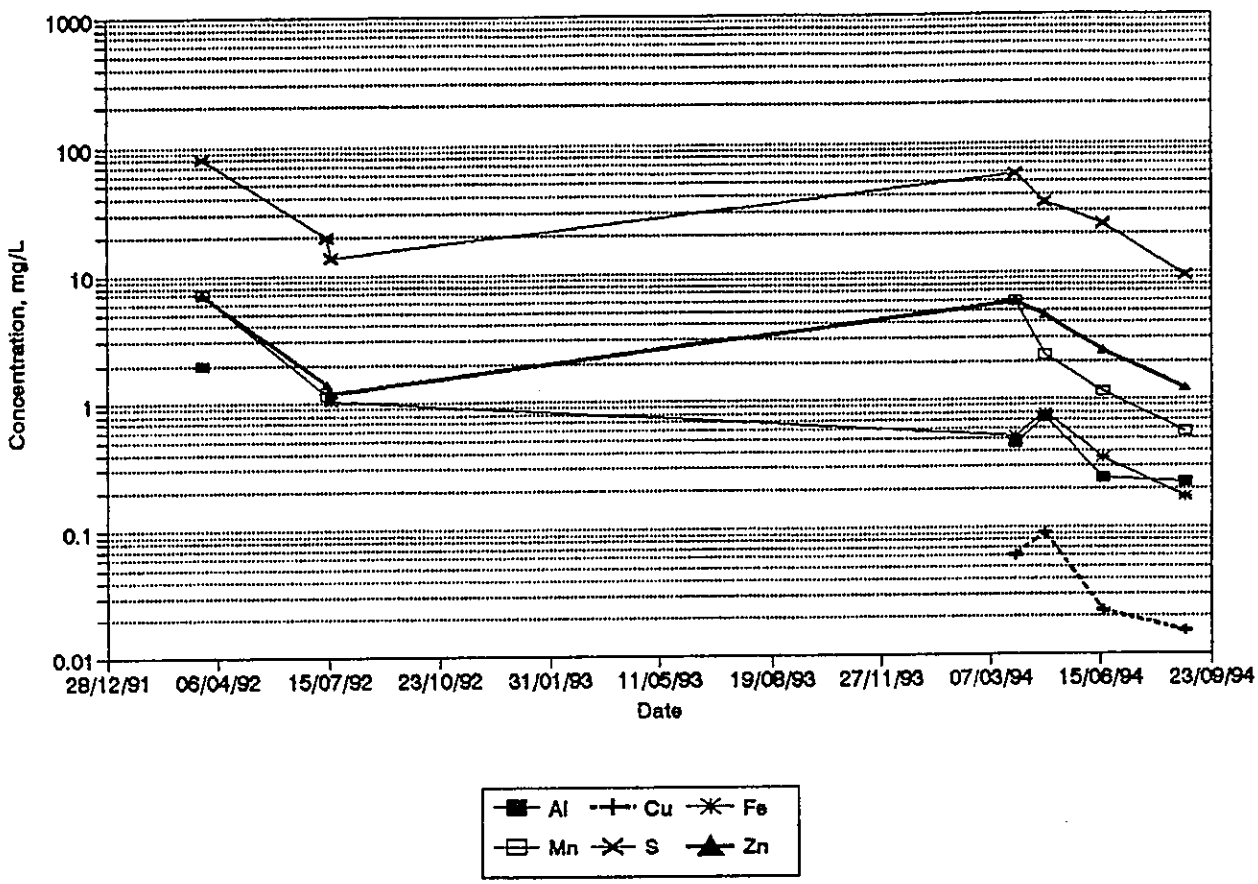


FIGURE 7

South Bay
Piezometer M-18

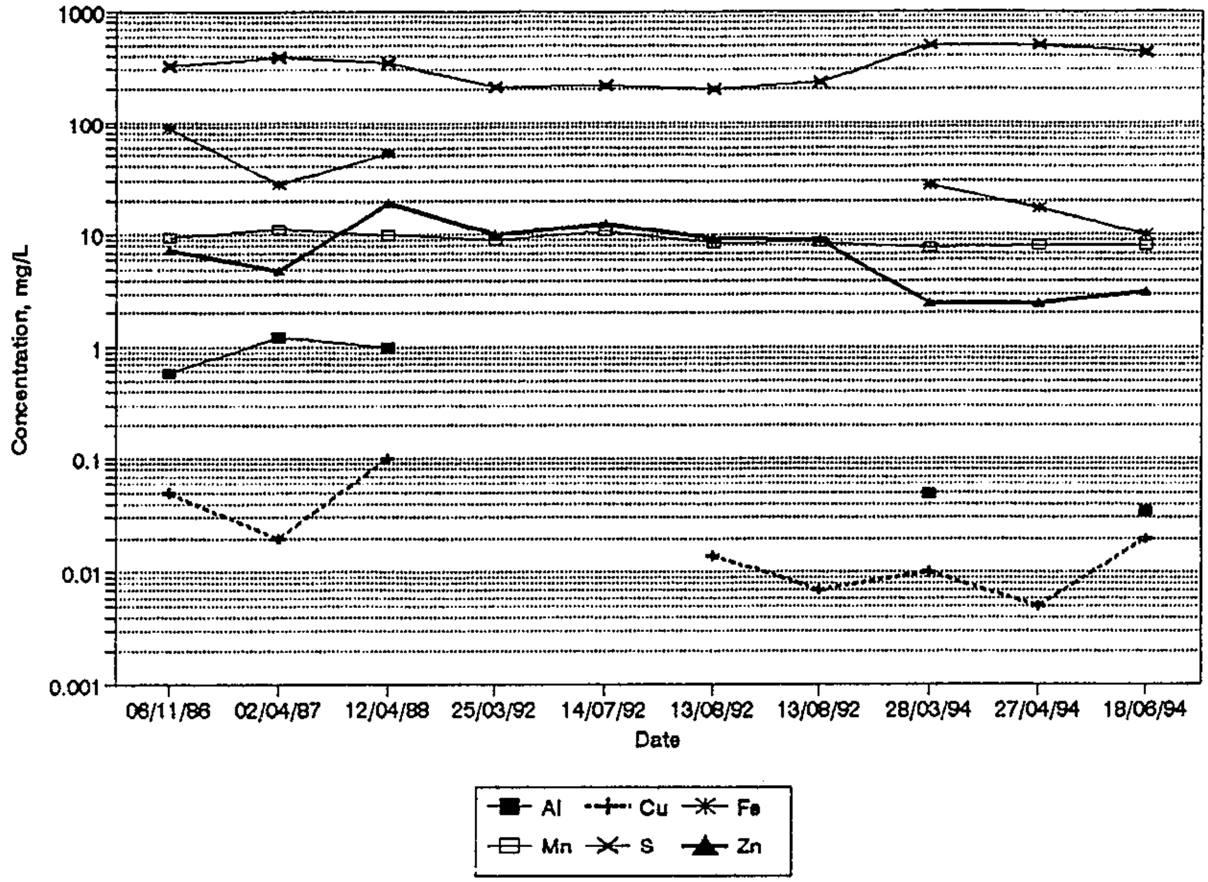


FIGURE 8

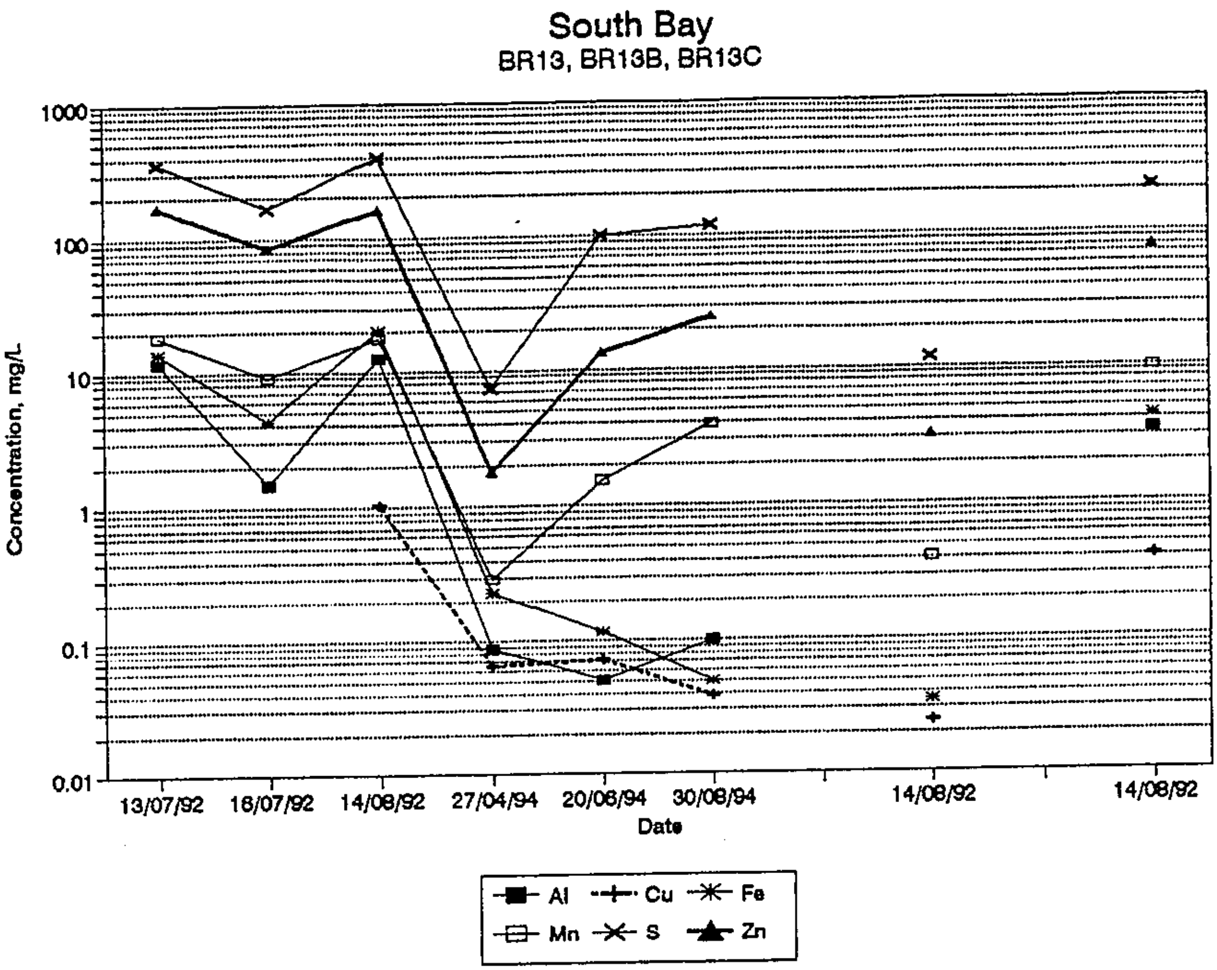

South Bay
BR13, BR13B, BR13C
1000
100
10
1
0.1
0.01
Concentration, mg/L
13/07/92
16/07/92
14/08/92
27/04/94
20/06/94
30/08/94
14/08/92
14/08/92
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 9

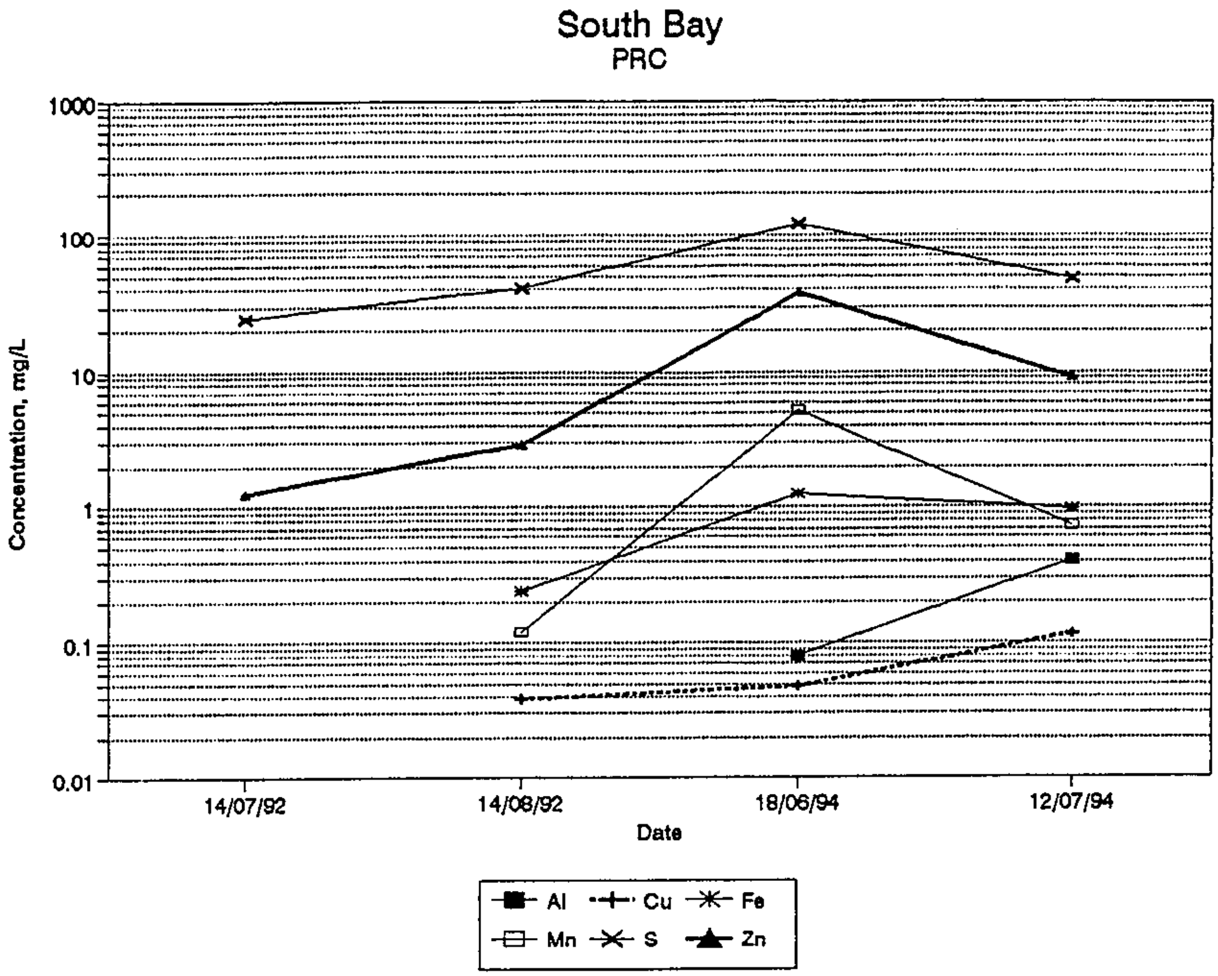

South Bay
PRC
1000
100
10
1
0.1
0.01
Concentration, mg/L
14/07/92
14/08/92
18/06/94
12/07/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 10

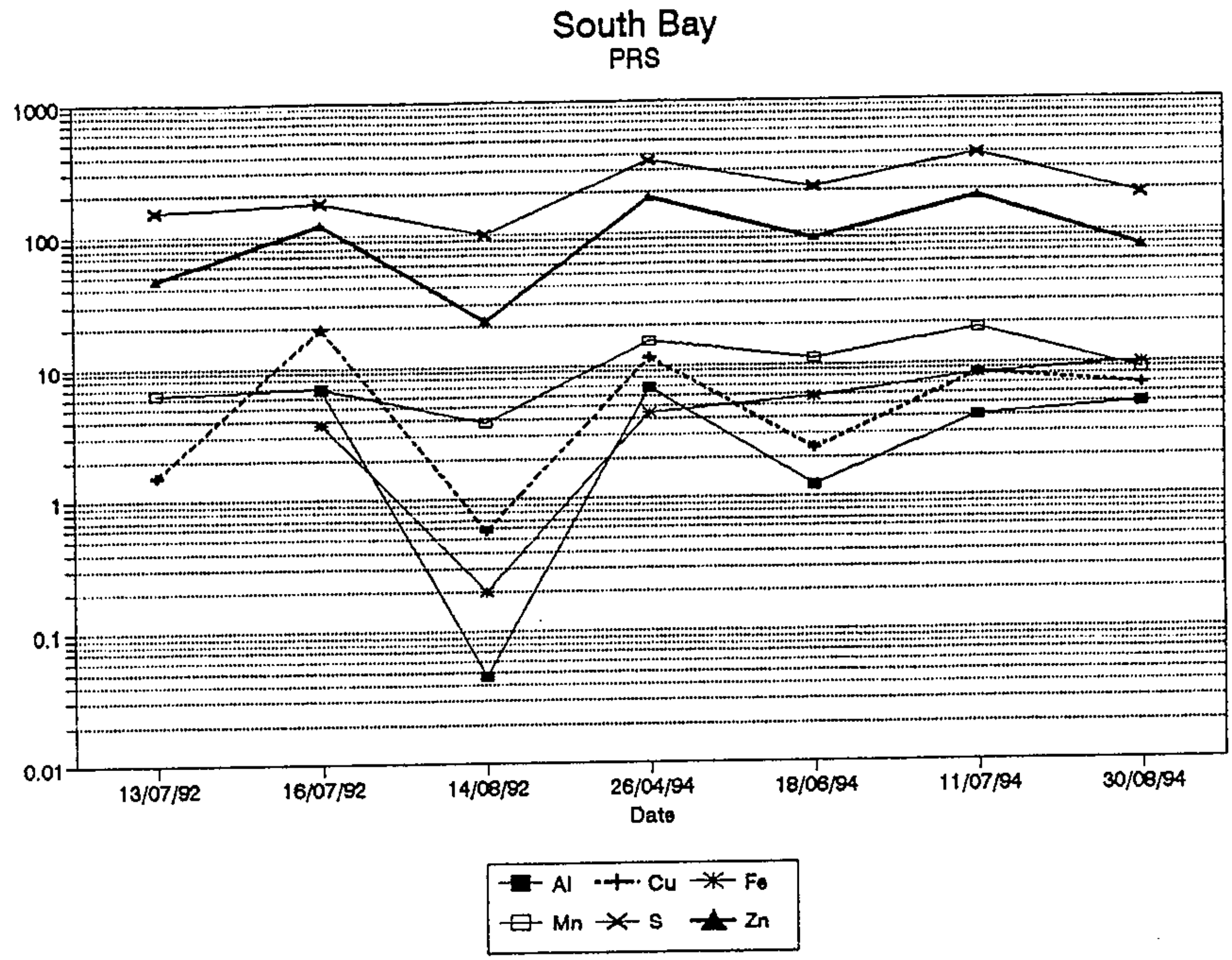
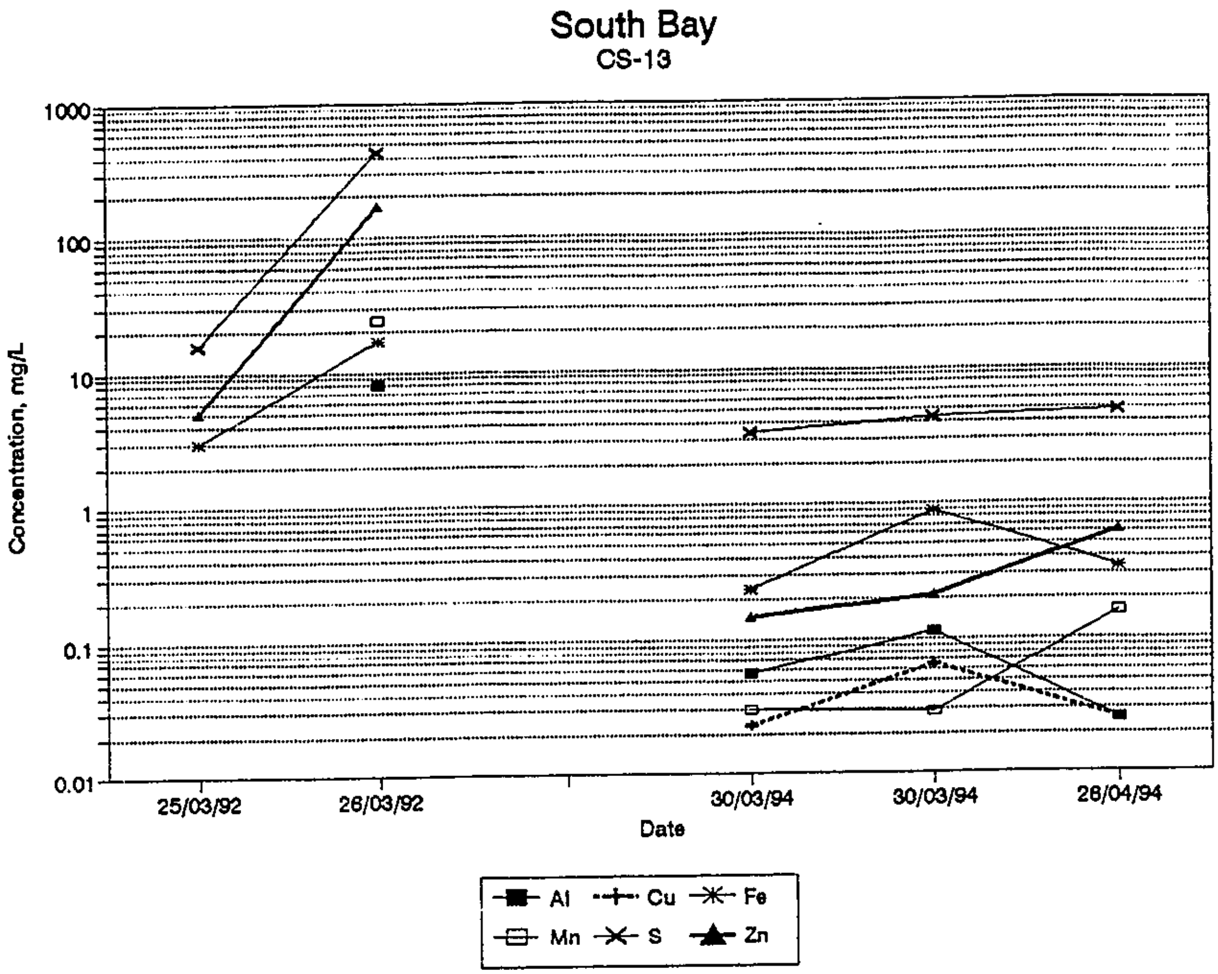

South Bay
PRS
1000
100
10
1
0.1
0.01
13/07/92
16/07/92
14/08/92
26/04/94
18/06/94
11/07/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 11



South Bay
CS-13
1000
100
10
1
0.1
0.01
Concentration, mg/L
25/03/92
26/03/92
30/03/94
30/03/94
26/04/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 12

South Bay
Piezometer M-54

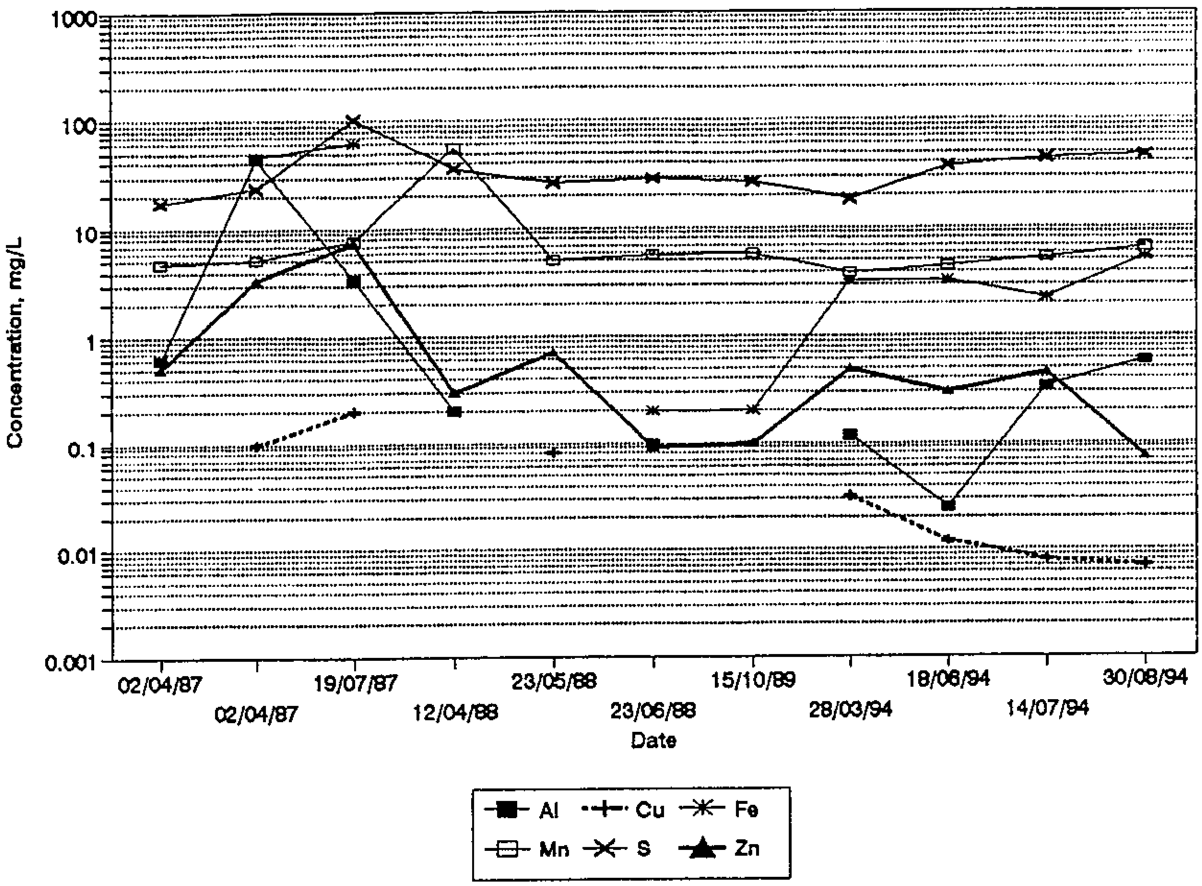
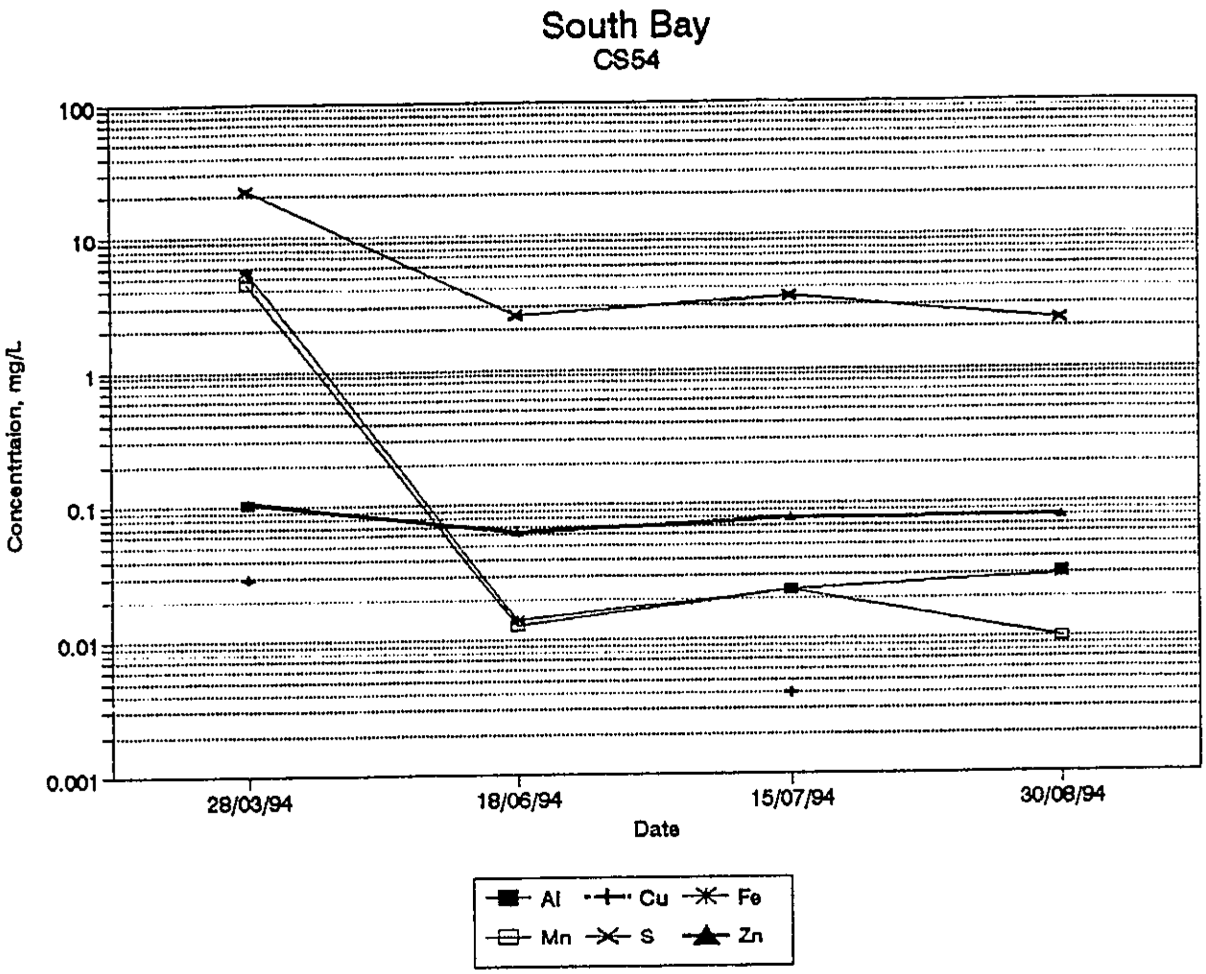


FIGURE 13



South Bay
CS54
100
10
1
0.1
0.01
0.001
Concentrtaion, mg/L
28/03/94
18/06/94
15/07/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 14

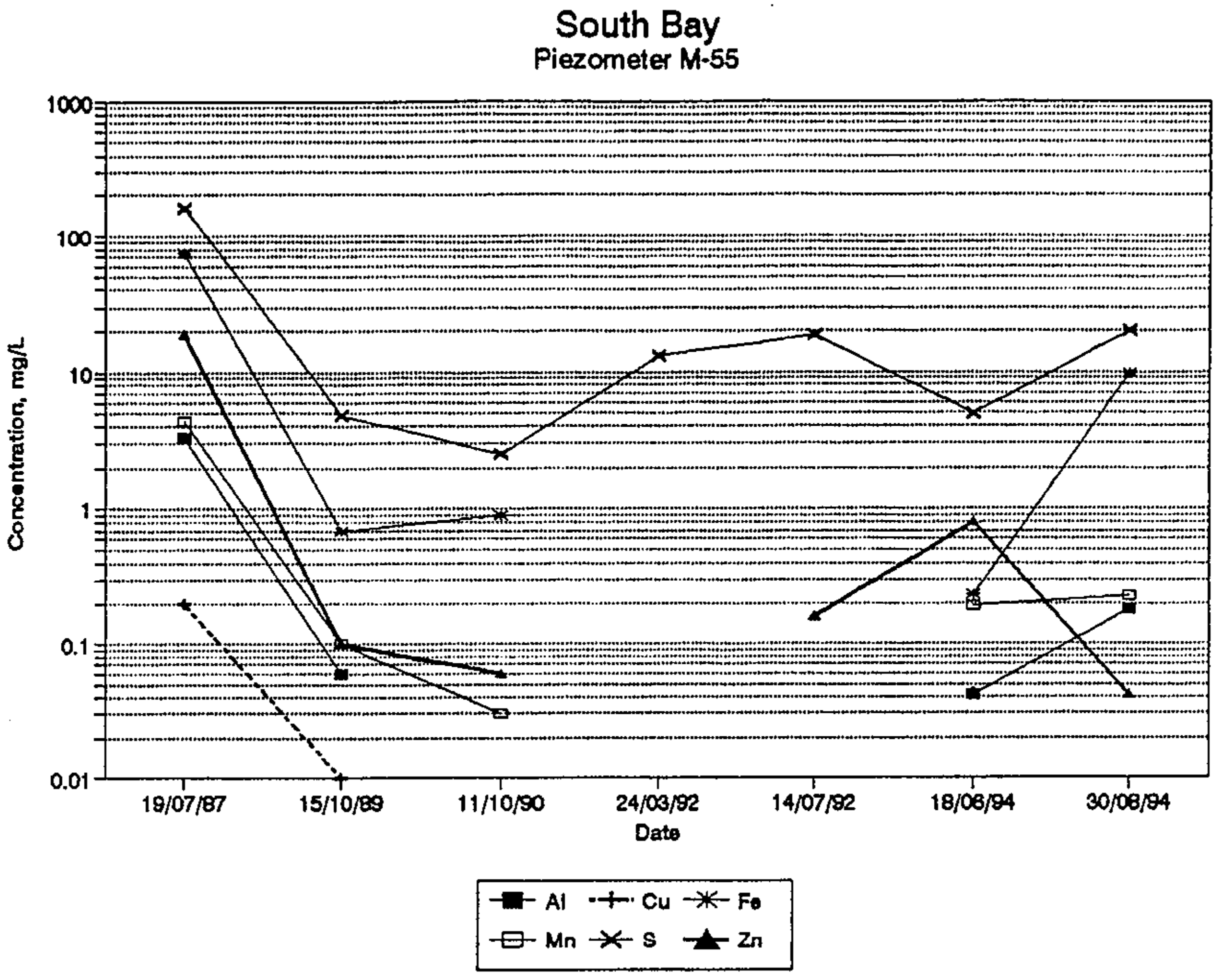

South Bay
Piezometer M-55
1000
100
10
1
0.1
0.01
Concentration, mg/L
19/07/87
15/10/89
11/10/90
24/03/92
14/07/92
18/08/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 15

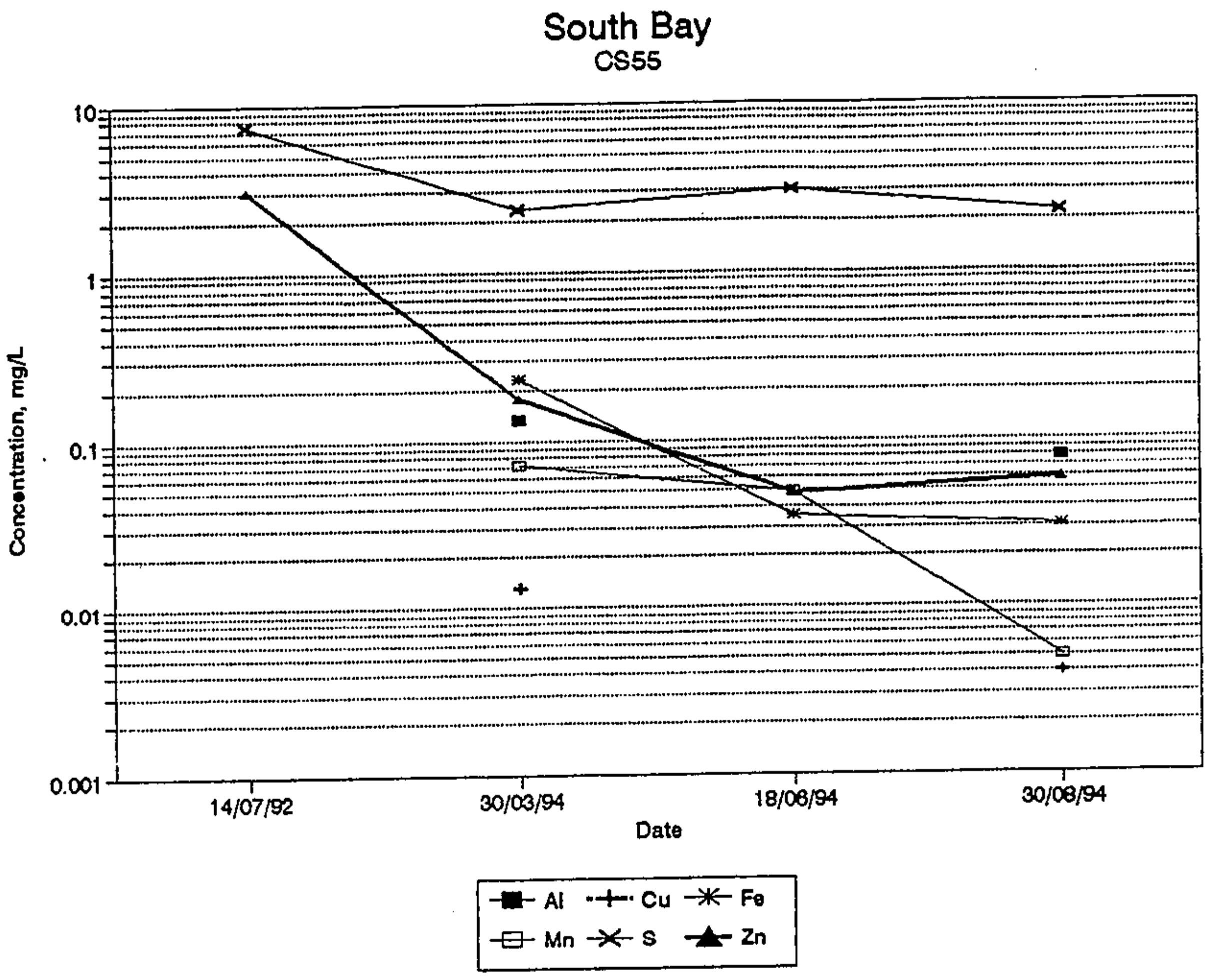
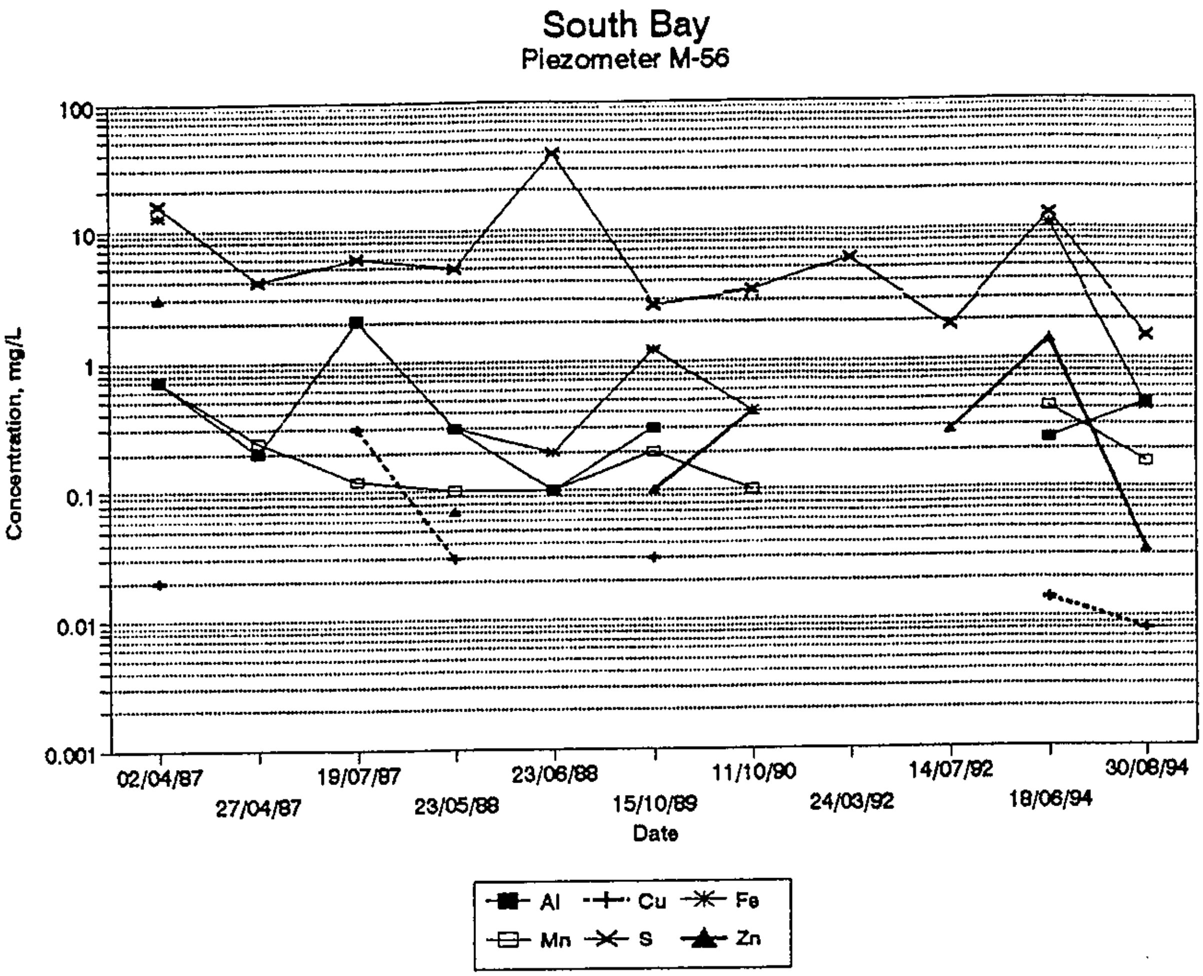

South Bay
CS55
10
1
0.1
0.01
0.001
Concentration, mg/L
14/07/92
30/03/94
18/06/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 16



South Bay
Piezometer M-56
100
10
1
0.1
0.01
0.001
Concentration, mg/L
02/04/87
27/04/87
19/07/87
23/05/88
23/06/88
15/10/89
11/10/90
24/03/92
14/07/92
18/06/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 17

South Bay
CS56

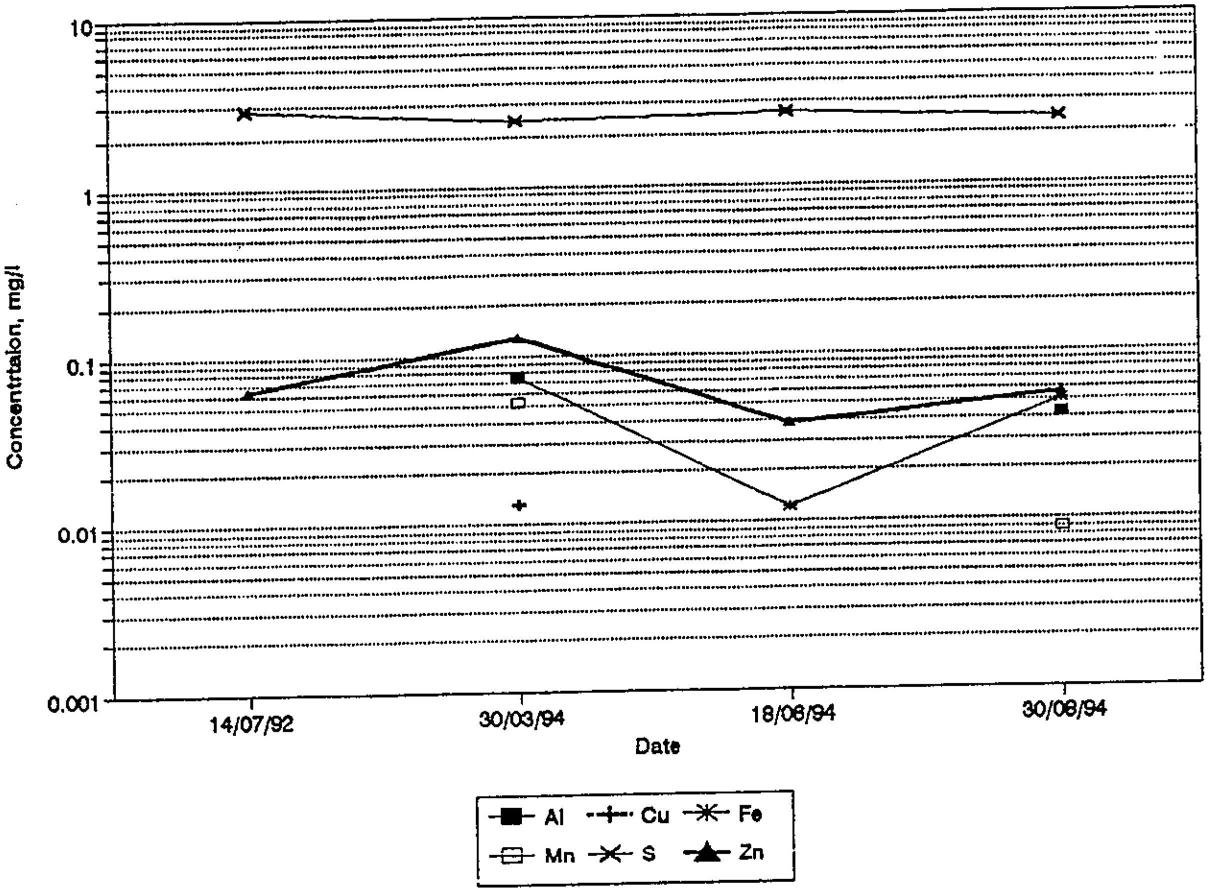


FIGURE 18

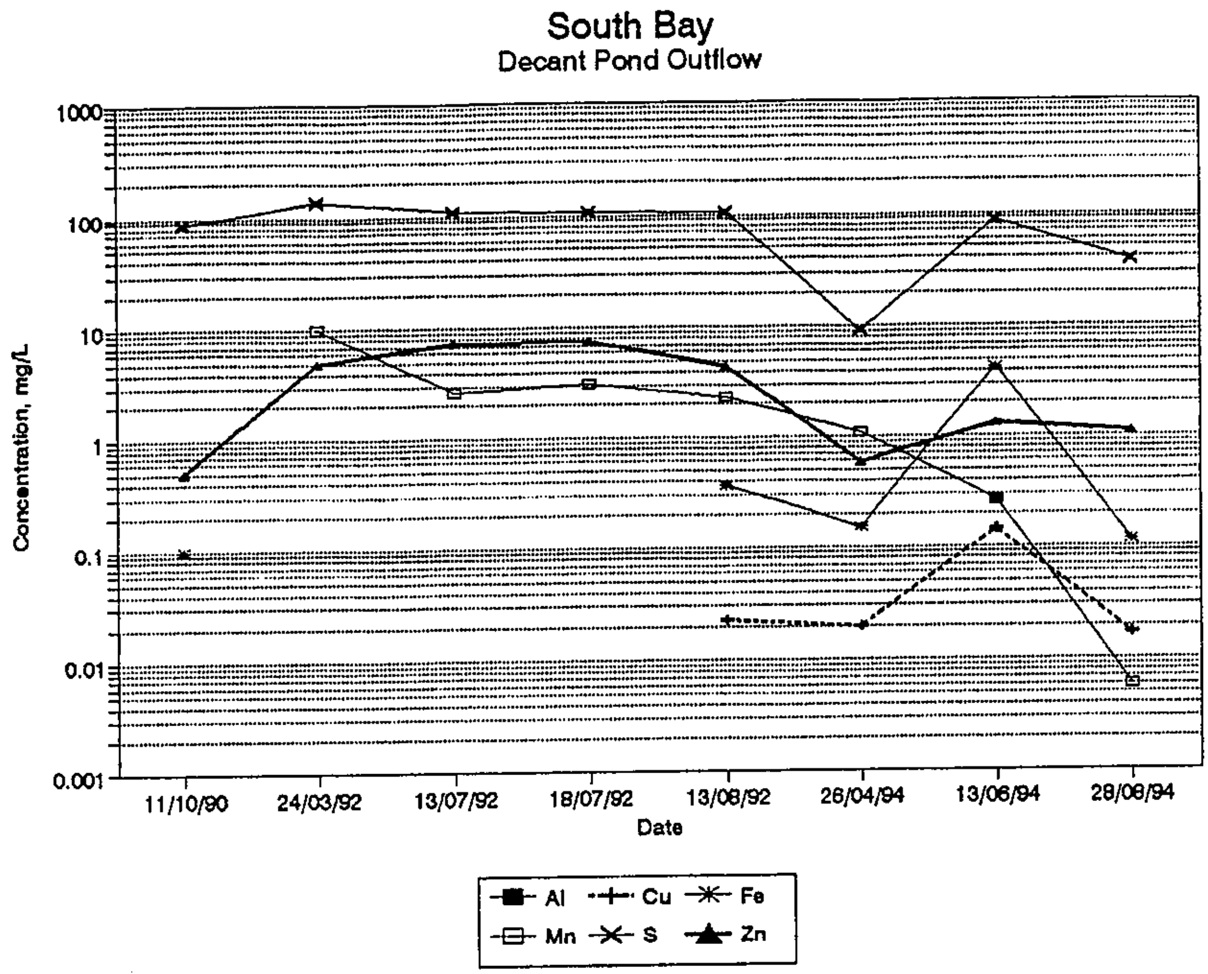

South Bay
Decant Pond Outflow
1000
100
10
1
0.1
0.01
0.001
Concentration, mg/L
11/10/90
24/03/92
13/07/92
18/07/92
13/08/92
26/04/94
13/06/94
28/06/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 19

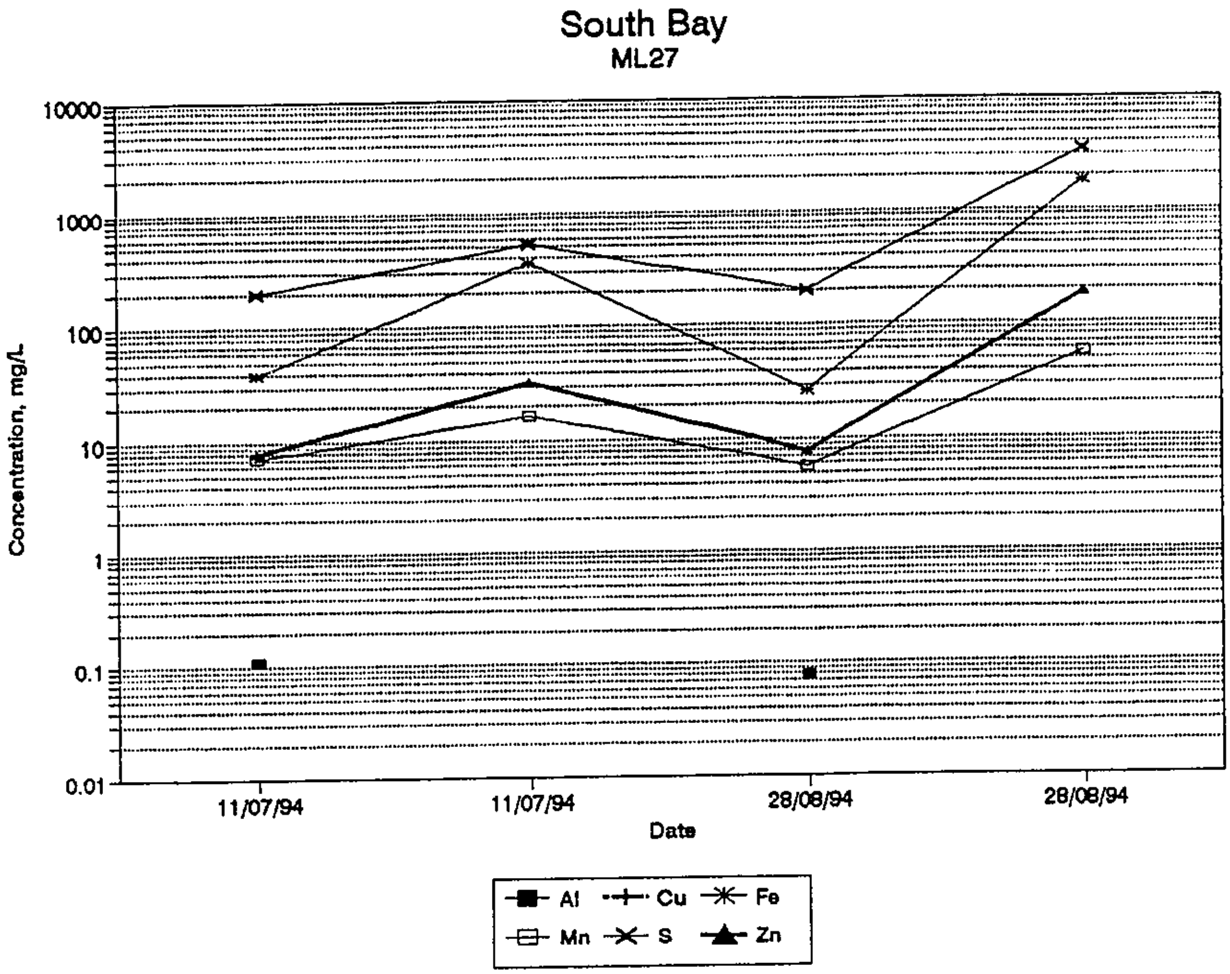

South Bay
ML27
10000
1000
100
10
1
0.1
0.01
Concentration, mg/L
11/07/94
11/07/94
28/08/94
28/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 20

South Bay
ML18

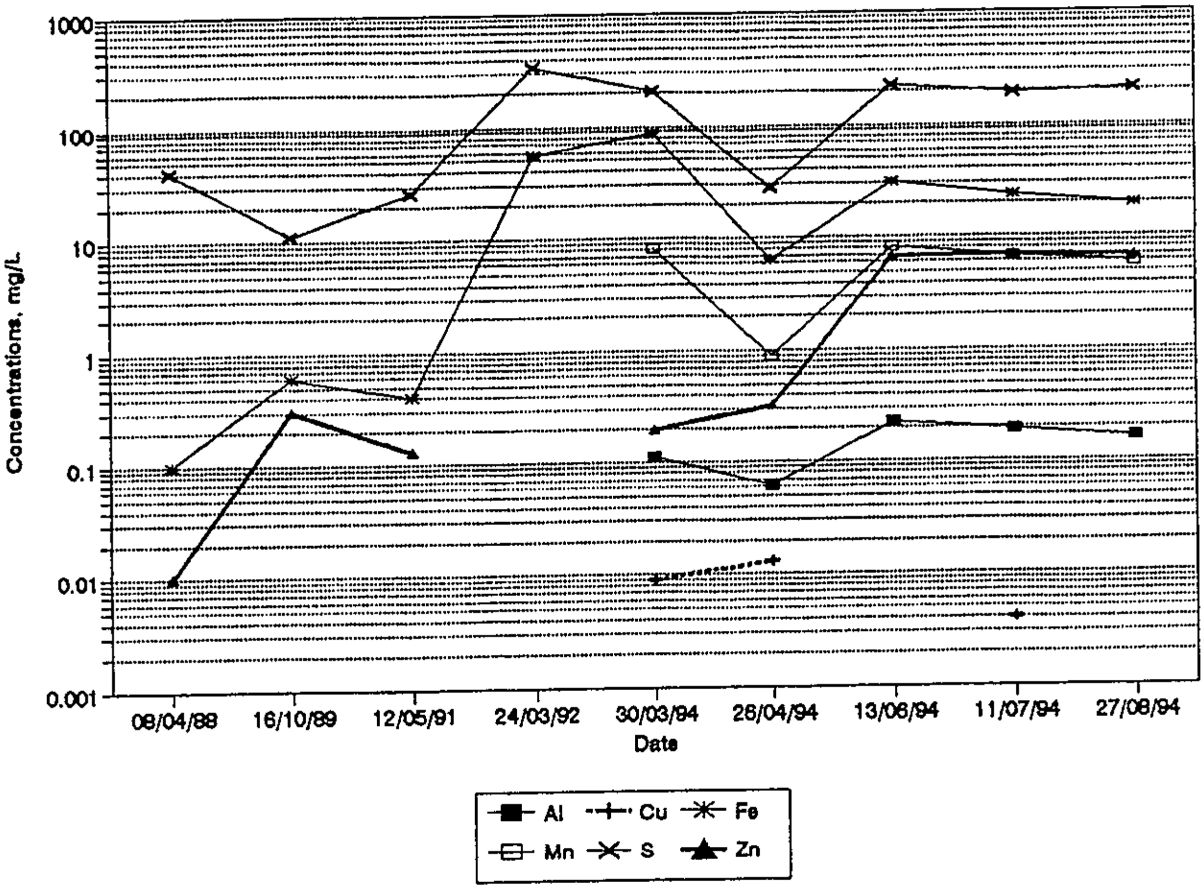


FIGURE 21

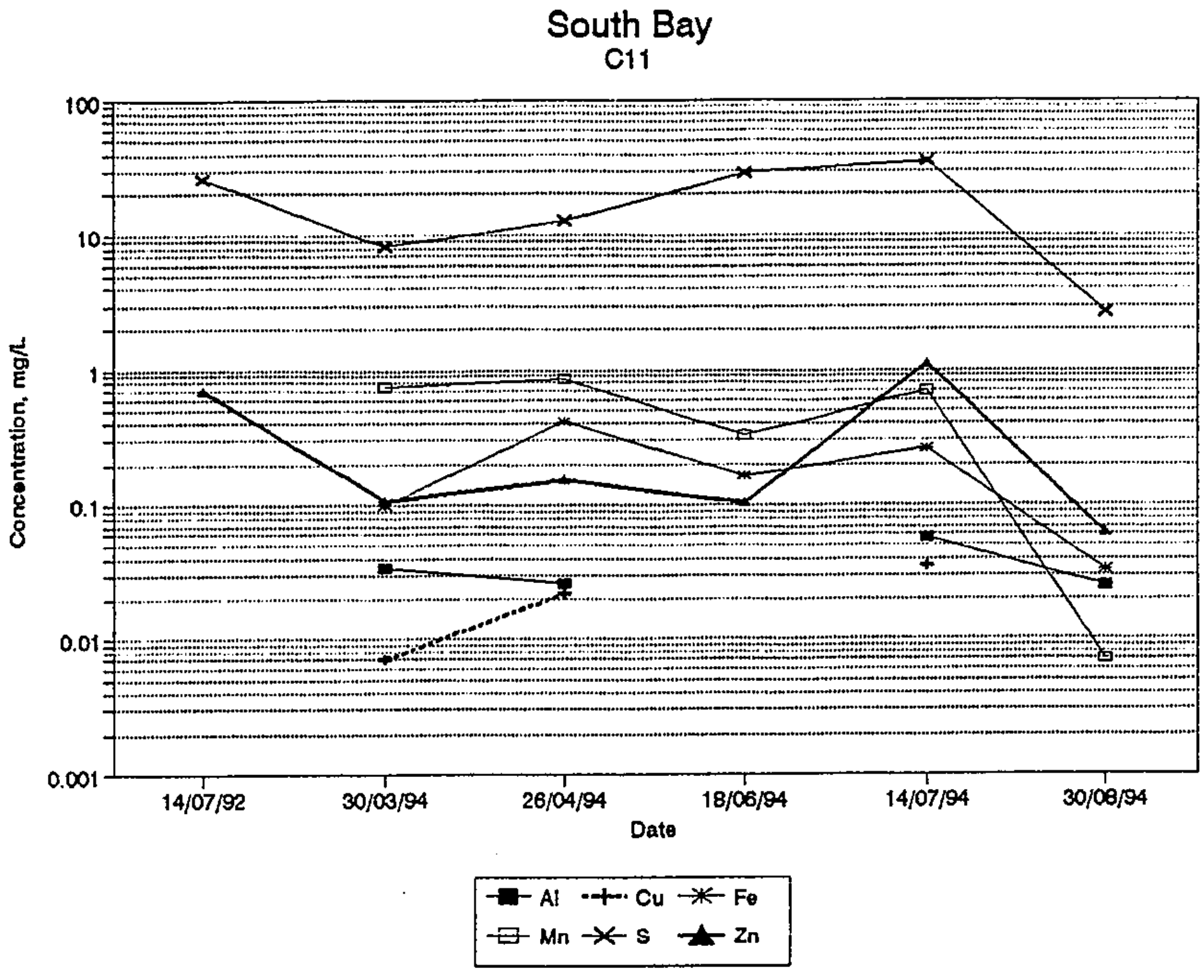
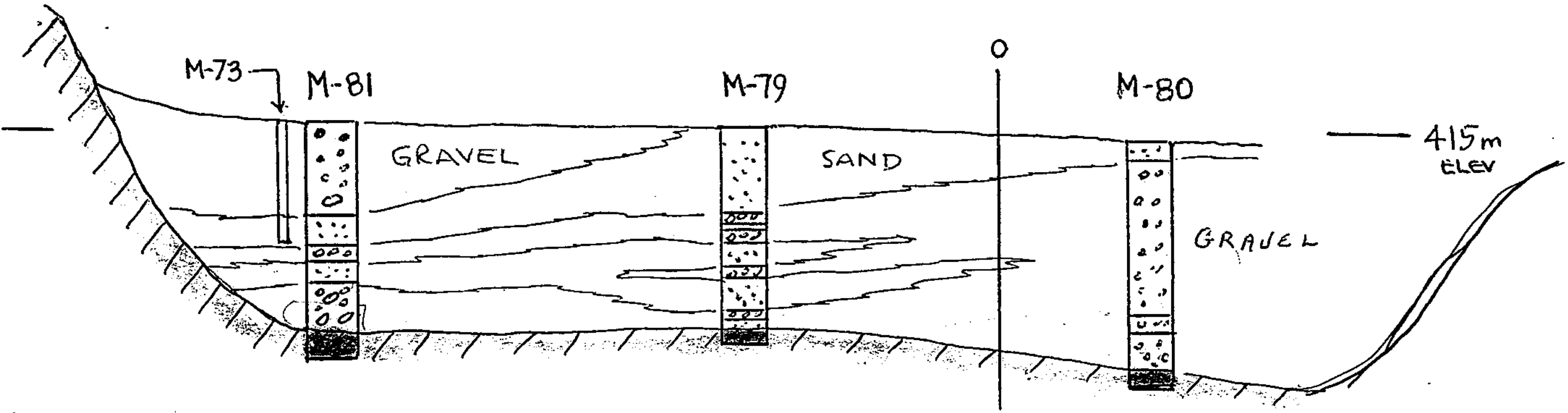
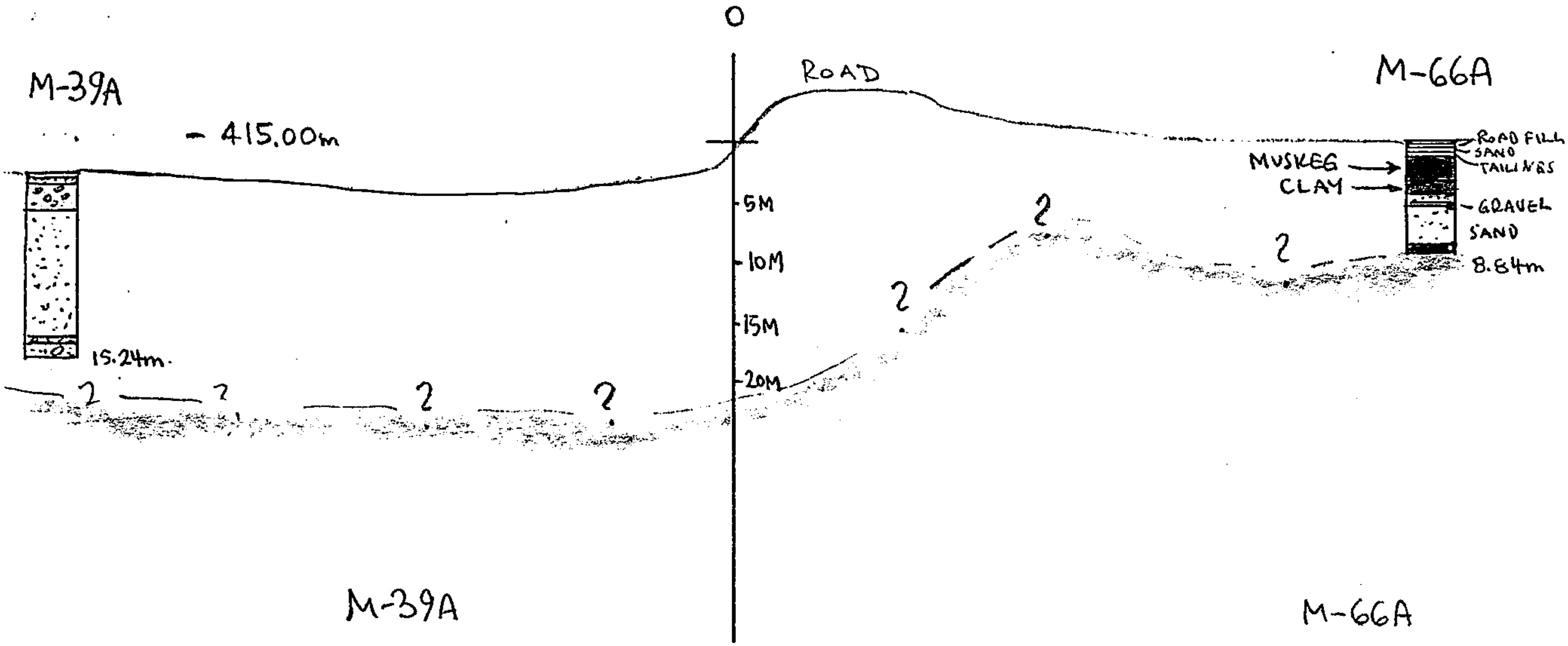

South Bay
C11
100
10
1
0.1
0.01
0.001
Concentration, mg/L
14/07/92
30/03/94
26/04/94
18/06/94
14/07/94
30/08/94
Date
Al
Cu
Fe
Mn
S
Zn

FIGURE 22



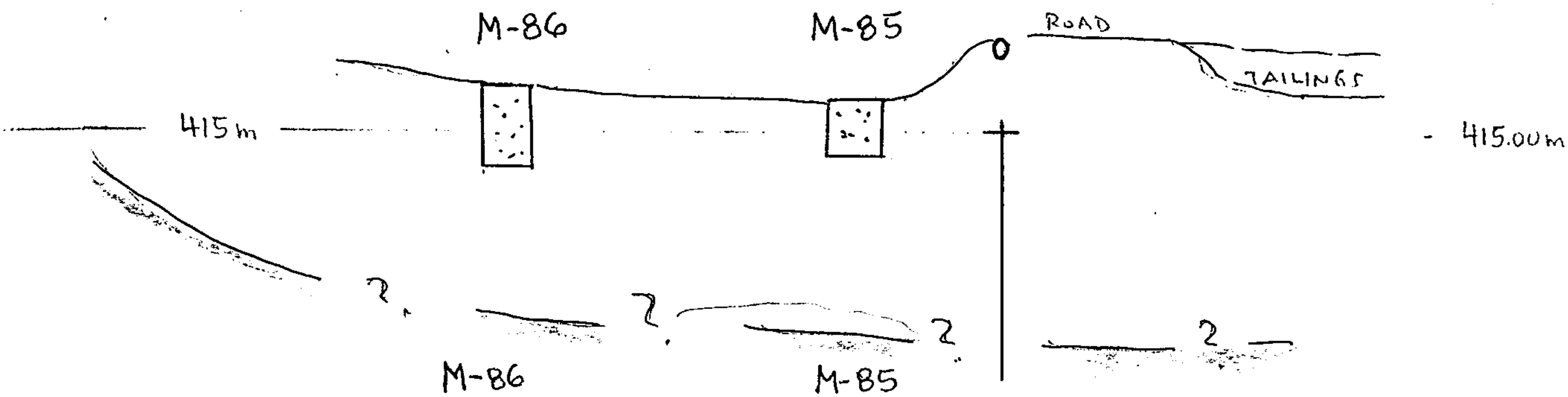
DATE	MAY	AUG	OCT	MAY	AUG	OCT	MAY	AUG	OCT
ZINC (mg/L)	146	—	125	158	—	140	148	—	130
CONDUCTIVITY (FIELD)	2780	6130	5230	3378	6290	6120	3095	6140	5820
ACIDITY (LAB)	2964	8691	2772	3416	3738	2178	3374	5195	3823
Eh (LAB)	+130	−47	323	+90	−56	220	+87	−47	315
IRON (mg/L)	1950	—	1330	2380	—	1670	2450	—	1670

SCHEMATIC 1 - SECTION 200m N



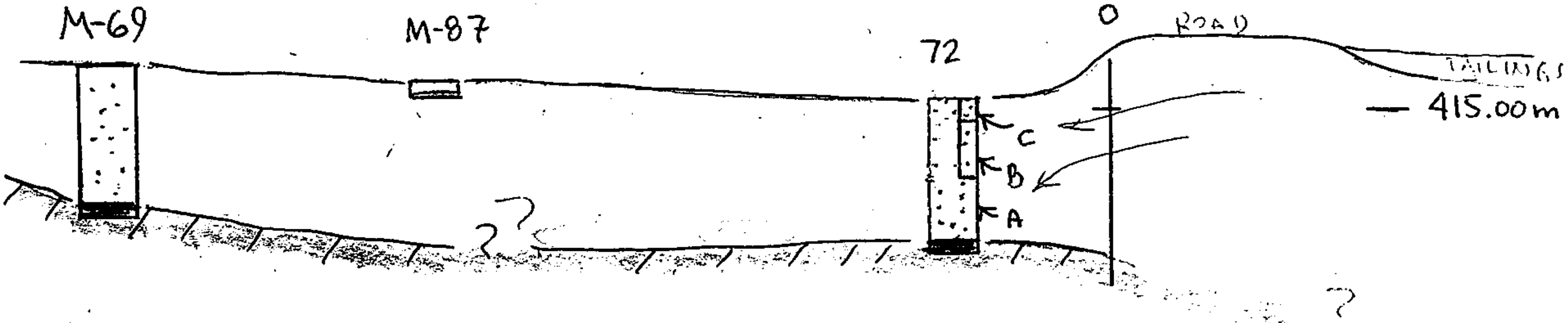
DATE	SEPT '94	AUG '95	OCT	MAY	AUG
ZINC	168	—	13.2	60	—
CONDUCTIVITY	4750	3445	1132	1071	2600
ACIDITY	2753	2545	298	542	900
Eh	-115	+28	358	62	-1
IRON	1560	—	83.1	—	—

SCHEMATIC 2 - SECTION 0+50mN



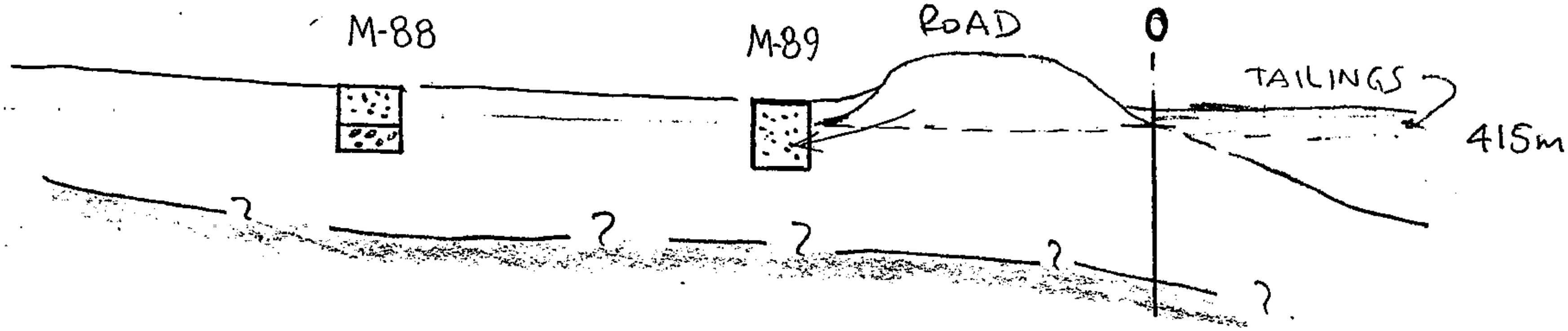
DATE	MAY	OCT	MAY	OCT
ZINC (mg/L)	0.15	0.241	1.82	1.58
COND. (FIELD)	169	120	348	400
ACIDITY (LAB)	21	41.2	48	50.7
Eh (LAB)	+99	319	+90	339
IRON (mg/L)	0.08	1.27	0.22	1.23

SCHEMATIC 3 - SECTION 025mS



	M-69		M-87		M72B			M-72A			M-72C		
DATE	MAY		MAY	OCT	MAY	AUG	OCT	MAY	AUG	OCT	MAY	AUG	OCT
ZINC	0.89		0.24	0.187	734	—	377	13.5	—	14.9	1430	—	523
CONDUCTIVITY	271		81	76.3	3891	10530	11800	1130	2245	1930	5,731	15,050	14850
ACIDITY	14.6		15.8	19.3	5322	8757	7111	332	534	443	12,200	12,450	11064
Eh	-16		92	322	85	-13	397	43	-17	314	+287	+195	449
IRON	8.4		3.7	0.5	3590	—	196	253	—	144	7690	—	192

SCHEMATIC 4 - SECTION 0+50m S



		M-88			M-89				
DATE		MAY'95	AUG'95		MAY'95	AUG'95	OCT '95		
ZINC		0.64	—		157	—	10.3		
COND		77	—		1810	1360	2270		
ACIDITY		25	—		1360	666	1099		
Eh		+29	—		+455	+481	484		
IRON		1.8	—		223	—	52.4		

SCHEMATIC 5 - SECTION 0+75m S